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HAZARDOUS MATERIALS/HAZARDOUS WASTE STRATEGY(U)
CONSTRUCTION ENGINEERING RESEARCH LAB (ARMY) CHAMPAIGN
IL R E RIGGINS ET AL. APR 83 CERL-TR-N-145

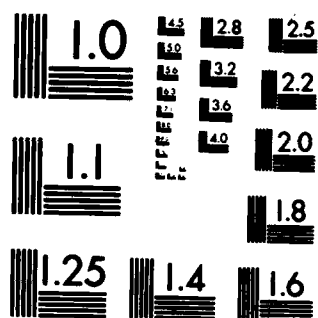
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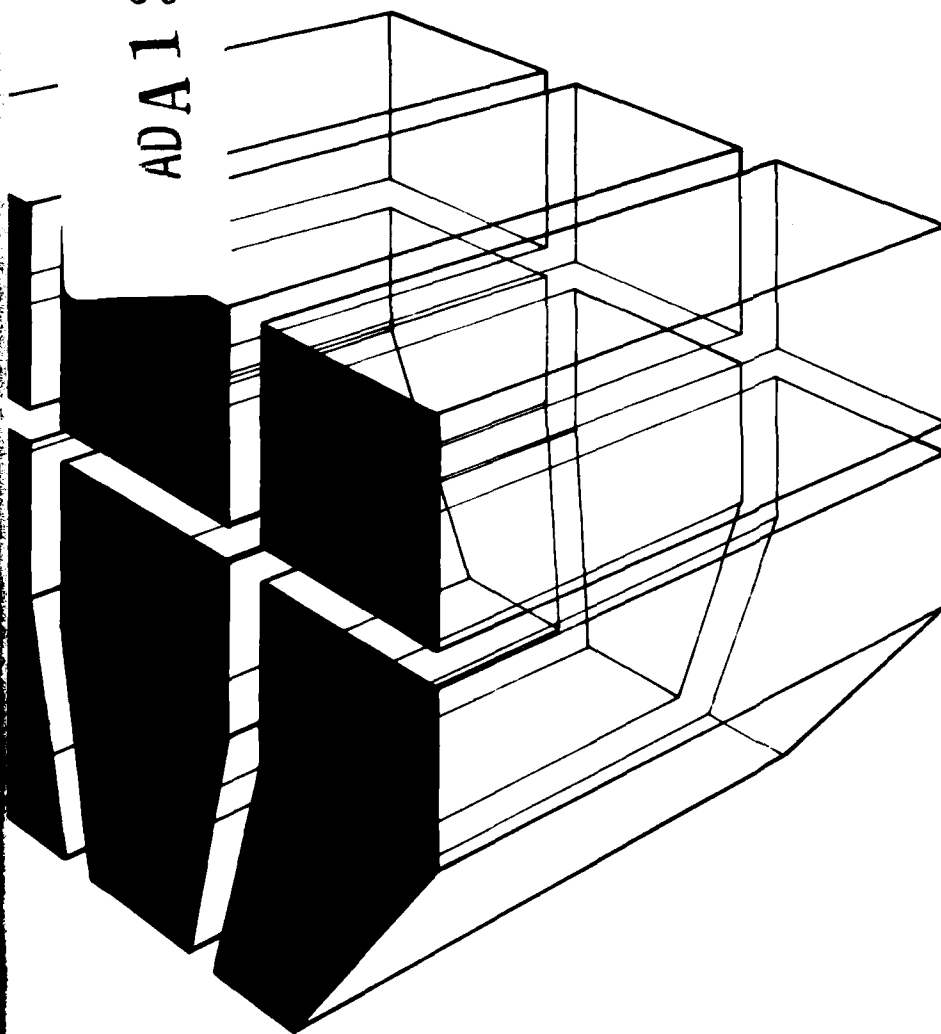


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TECHNICAL REPORT N-145
April 1983

HAZARDOUS MATERIALS/HAZARDOUS WASTE STRATEGY

ADA 130249



by
Robert E. Riggins
Walter J. Mikucki
Bernard A. Donahue
Manette Messenger

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methods to control or treat leachate, (5) evaluation of hazardous waste disposal options, and (6) development of biotechnology methods to neutralize or consume certain types of wastes.

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FOREWORD

This research was performed for the Assistant Chief of Engineers, under Project 4A162720A896, "Environmental Quality Technology"; Technical Area A, "Installation Environmental Management Strategy"; Work Unit 027, "Installation Environmental Management Strategy Program Development." The work was done by the Environmental Division (EN), U.S. Army Construction Engineering Research Laboratory (CERL). The Technical Monitor was Mr. David Palmer, DAEN-ZCE.

Dr. R. K. Jain is Chief of CERL-EN. COL Louis J. Circeo is Commander and Director of CERL, and Dr. L. R. Shaffer is Technical Director.

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HAZARDOUS MATERIALS/HAZARDOUS WASTE STRATEGY

1 INTRODUCTION

Background

Laws and regulations such as the Resource Conservation and Recovery Act of 1976 (RCRA), the Toxic Substance Control Act of 1976 (TSCA) and the Comprehensive Environmental Response, Compensation and Liability Act (SUPER FUND) have greatly changed waste disposal options and required changes in how hazardous substances are managed. However, the Army has not been granted any exceptions in complying with Federal and state hazardous waste management laws and regulations.

In May 1980, the Defense Logistics Agency (DLA) was designated the Department of Defense (DOD) manager for centralized Hazardous Materials/Hazardous Waste (HM/HW) disposal. However, Army installation commanders will continue to have overall responsibility for administering regulated waste management facilities and for all hazardous wastes excluded from DLA management. The installation commander is responsible for complying with Federal, state, and local regulations and permit/manifest reporting requirements.

In October 1980, DOD policy was extended and clarified to require all DOD components to:

1. Reduce hazardous waste generation to the maximum extent
2. Reuse, reclaim, or recycle resources where practical
3. Implement U.S. Environmental Protection Agency (USEPA) hazardous waste management regulations.

To carry out these policies, the Army needed an R&D program that would provide the technology and capability for the Army installation commander to carry out these mission requirements efficiently, affordably, and with the fewest personnel resources. A hazardous waste user group was formed to identify HM/HW problems and monitor on-going research. The initial meeting of the user group was held 24 June 1982; this group established the basis for HM/HW R&D program development (see the appendix).

Purpose

The purpose of this report is to describe the proposed hazardous materials/hazardous waste R&D program.

Approach

The HM/HW flow process at the installation level was established. This process was then used as a basis to outline an R&D program which would best meet the installations' needs (Chapter 2). Installation needs were categorized into five general areas which corresponded to current DOD HM/HW policies. Next, six product/systems and related research activities were developed which would provide the technology to implement DOD policies (Chapter 3). Finally, the status of current, on-going research was investigated (Chapter 4).

2 THE HM/HW PROCESS AT THE INSTALLATION LEVEL

Army Installation HM/HW Mission Implementation

Army policy for HM/HW is being established through revisions to AR 200-1 and AR 420-47.¹ Information taken from these regulations and from field studies at several military installations was used to construct the HM/HW process at the installation level (see Figure 1). Materials which are hazardous or become hazardous wastes after use come onto installations through the procurement function. Materials are issued and eventually used. Materials not consumed during use become waste. Waste disposition requires collection and storage. Waste disposition options for the installation are, in order of preference, recycle (includes resale), transfer to the Defense Property Disposal Office (DPDO), contract disposal, or on-post disposal. Most hazardous wastes are within the DLA scope and would be transferred to DPDO.

R&D Needed To Support Army Installation HM/HW Mission Implementation

The installation HM/HW process chart has been expanded (Figure 2 and Table 1) to provide a basis for the HM/HW research program and to show more detail. This expanded chart includes activities which support the HM/HW flow and documents which

¹Environmental Protection and Enhancement, AR 200-1 (Department of the Army, 15 June 1982); Solid Waste Management, AR 420-47 (Department of the Army, 9 June 1977).

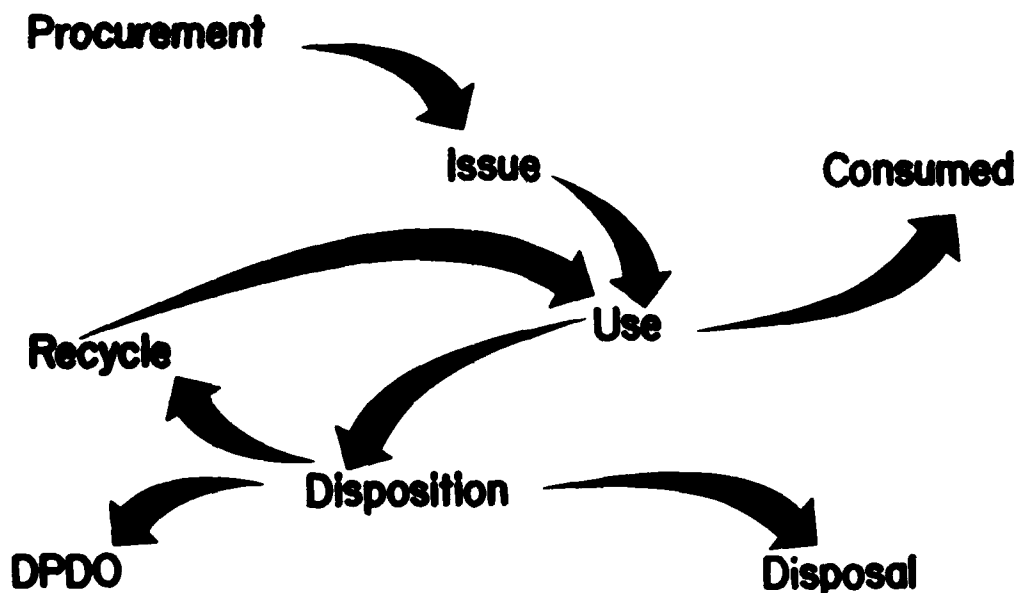


Figure 1. General flow of HM/HW at an installation.

impact the process. This representation of the process and associated information provides a framework for identifying research problems or needs. Problem descriptions and proposed research products are also shown. The information in the chart was used to develop the HM/HW research program described in Chapter 3.

3 PROPOSED HM/HW R&D

Problems and Needs

The problems or needs shown in Table 1 can be placed in five general categories: information management, materials handling guidance, hazard elimination technology, disposal technology, and construction design guidance. Waste storage facility construction design technology is DLA's responsibility. Hazard elimination corresponds to requirements 1 and 2 on page 5; the other three categories correspond to requirement 3.

Table 2 shows the HM/HW strategy elements developed for the research program. The six product/systems and related research activities are listed in

order of priority. Table 3 shows the scheduling for developing them. Key events are described in Table 4.

Proposed Research Program Products/Systems

Product #1: Hazardous Materials Management System (HMMS)

Effective HM/HW management requires information which identifies and characterizes hazardous materials. The amount of each material entering the installation must be determined, and the proper procedures for storing and handling it must be known. Installation personnel need a quick, effective procedure for obtaining this information. Materials can be partially quantified through interface with the Standard Army Intermediate Level Supply (SAILS) system; however, local procurement presents unique problems. Another problem area is tracking wastes from "cradle to grave." HM/HW management is affected by rapidly changing requirements and technology. Information must be disseminated systematically if installation personnel are to successfully complete the HM/HW mission. The development of an information system is high priority.

Field studies at Fort Hood, TX, Fort Campbell, KY, Fort Knox, TN, and other installations have indicated that effective hazardous waste management depends greatly on proper waste handling immediately after

HAZARDOUS MATERIALS / HAZ

POLICY:

AR 200-1
AR 420-47

PLANNING ➤

PROCUREMENT ➤

ISSUE ➤

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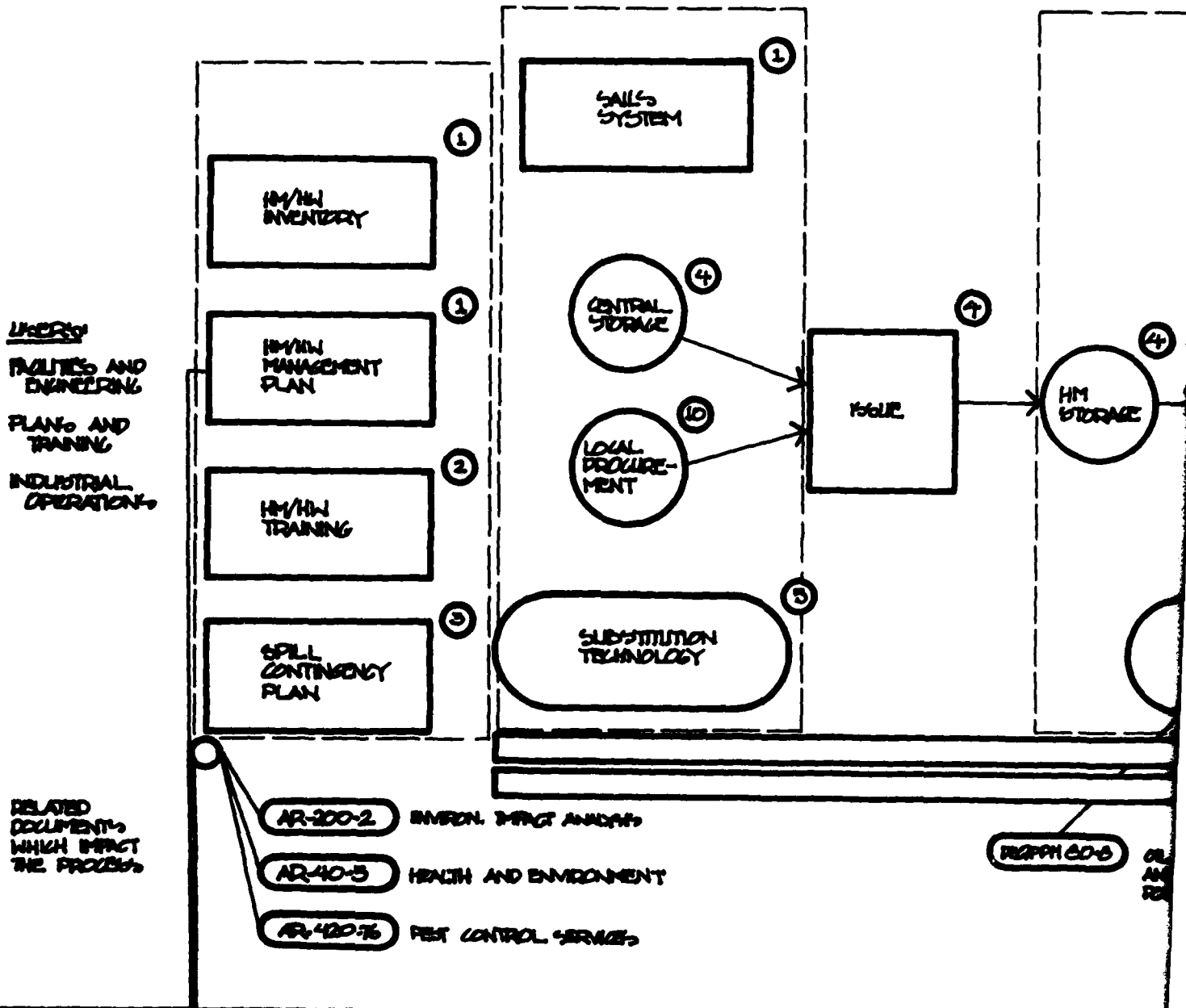


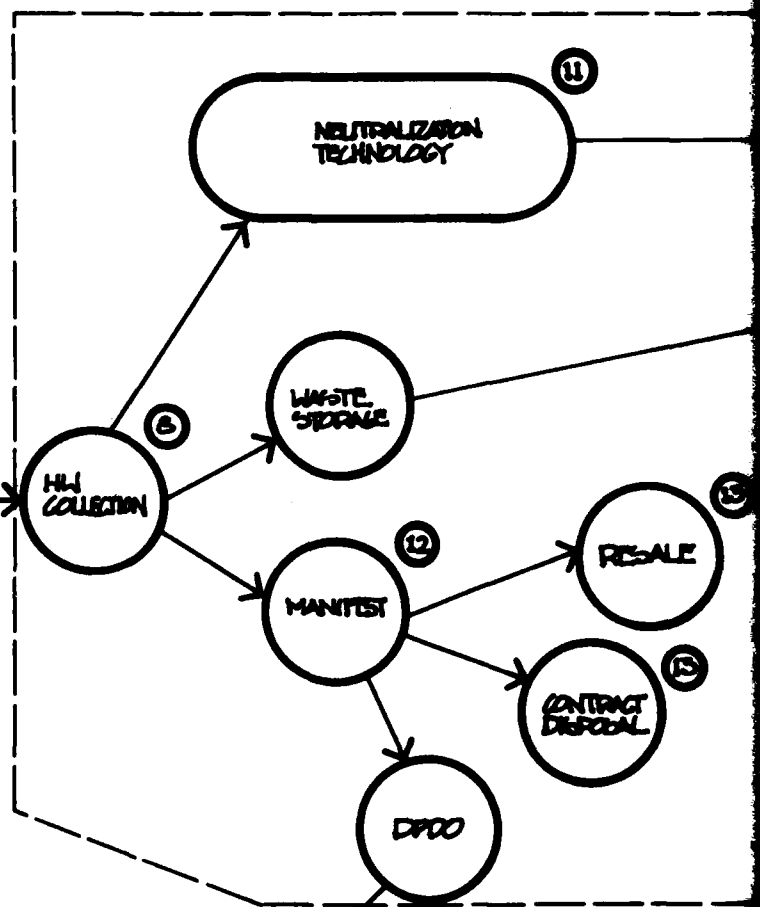
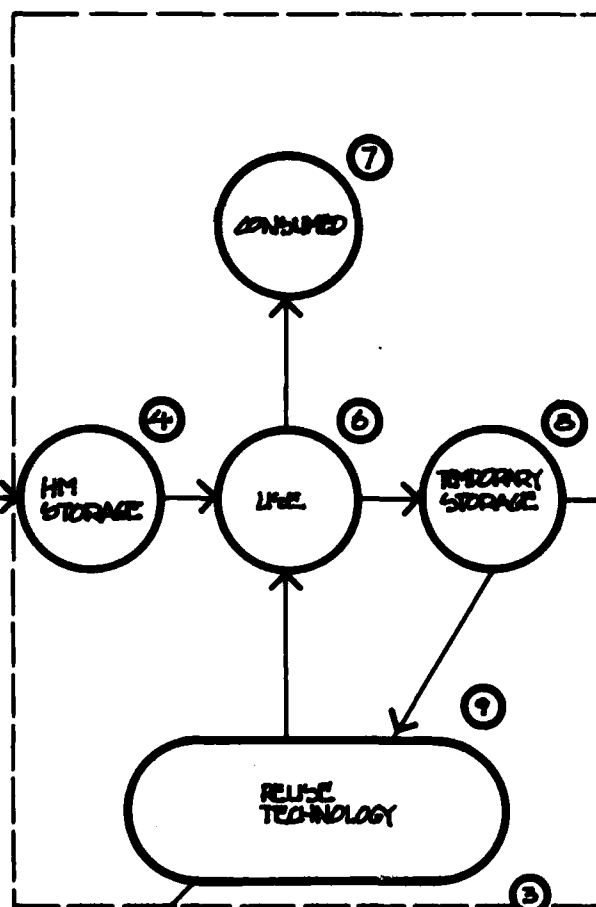
Figure 2. HM/HW process (expanded).

HAZARDOUS WASTE MANAGEMENT PROCESS

USE



DISPOSITION

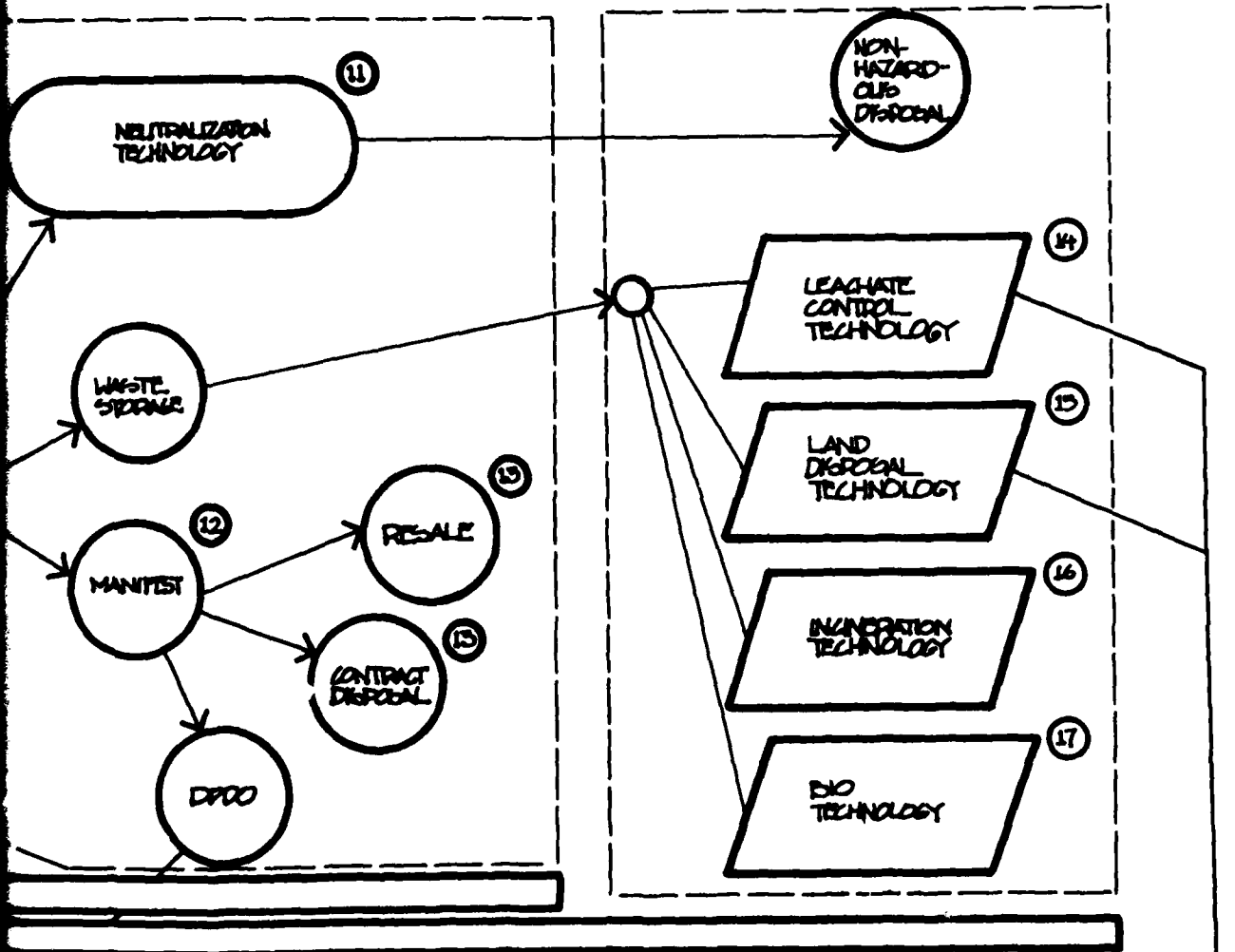


WASTE MANAGEMENT PROCESS

DISPOSITION



DISPOSAL



DDO 416A-21-11 DEFENSE DISPOSAL MANUAL

DAFM 420-4 SOLID WASTE DISPOSAL

DDPM 60-5 HAZARDOUS MATERIAL DISPOSAL PROGRAM

THS-614-5 SANITARY LANDFILLS

THS-634 REFUSE COLLECTION AND DISPOSAL

DDO 416A-21-11 RECEIVING OPERATIONS AT DPDO

MANAGEMENT OF RES

Table 1
Explanation of Numbers Coded Into Process Flow
Chart of Figure 2

Problem or Need	Description of Need	Solved by
1. Hazardous Materials Management System	An information system is needed to identify, characterize and quantify hazardous materials for use in inventory and management, and also to produce information on new technology and guidance.	User manual; training materials; computerized system.
2. Training Materials	Documents are needed to train operations personnel in proper handling of hazardous materials and wastes. Changes in O&M procedures may also be required.	New DA Pamphlet on HM/HW management in O&M activities.
3. SPCC Development	Procedures for containment need to be developed or upgraded. Guidance on plan execution needs to be provided.	Revision to AR 200-1; contribute to a new TM on HM/HW management technology.
4. Hazardous Materials Handling and Storage	Procedures are needed and guidance must be provided for proper handling, transport and storage of hazardous materials which utilize HM containers and facilities.	Contribute to new Army technical manual (TM) on HM/HW management technology.
5. Substitution Technology	Non-hazardous substitutes need to be developed where possible to eliminate hazardous materials use and hazardous waste generation.	Contribute to new TM on HM/HW management technology.
6. On-Site Materials Management Guidance	Better management techniques are needed for procedures which produce HW in order to facilitate acceptable disposal options.	Contribute to (HMMS).
7. Emission Factors	Emission factors are needed for HW in order to comply more effectively with reporting and inventory requirements.	Contribute to (HMMS).
8. Hazardous Waste Handling and Storage	Collection and storage guidance is needed to minimize spills, determine compatibility of mixing and maximize recovery and secondary utilization.	Contribute to new TM on HM/HW management technology and to HMMS.
9. Reuse/Recycle Technology	New technology is needed to maximize secondary utilization of hazardous materials. Hazard elimination through recycle/reuse is stressed in requirements documents.	Contribute to new TM on HM/HW management technology.
10. Tracking System	A system is needed to track hazardous materials and wastes through the process stream "cradle to grave."	Contribute to HMMS.

Table 1 (continued)

Problem or Need	Description of Need	Solved by
11. Neutralization Technology	Processes for hazard elimination through neutralization need to be developed and appropriate guidance needs to be provided.	Contribute to a new TM on HM/HW management technology.
12. Manifest Guidance	The current turn-in document needs to be upgraded to meet new state and Federal requirements. DPDO transferral documents need to be clarified.	DLA/EPA
13. Waste Exchange and Off-Post Disposal Guidance	Waste exchange information for minimum amounts, packaging and transportation is needed. Guidance on HW contractors and contract specifications is needed.	DLA
14. Land Disposal Technology	New technology and guidance is needed for safe and effective disposal of Army-unique hazardous wastes including co-disposal options.	Interim ETL. Revisions of TM 5-814-5, TM 5-634, DA PAM 420-4.
15. Leachate Control Technology	Technology and guidance is needed to prevent or treat leachate from sanitary landfills which contain Army-unique wastes.	Interim Engineer Technical Letters and Engineer Technical Notes. Revisions of TM 5-814-5. New TM on leachate control.
16. Biotechnology	New bacteria need to be developed which can degrade Army-unique hazardous wastes and decontaminate spills of hazardous wastes and materials.	New TM on biodegradation of hazardous materials.
17. Incineration Technology	Technology and guidance is needed for effective waste disposal via incineration.	New TM on incineration technology.

use. Hazardous waste collection, handling, and storage guidance are also priority research requirements. Waste control procedures vary, depending on the type of waste, and waste-specific guidance is needed. Currently identified priority wastes are POL, solvents, paint wastes, pesticides, and battery acids. These are emphasized largely because of their volume. Waste-specific management guidance for collecting, handling, storing, and transporting these wastes will be developed. Waste emission factors are also needed for effective tracking.

Product #2: Hazard Elimination/Minimization Technology

DOD policy specifically requires action to reduce hazardous waste generation and apply reuse/recycle where practical. This program considers four types of hazard elimination technology: substitution, reuse, recycle, and neutralization. Of these, only substitution requires coordination with DLA. Current plans are for DLA to begin substitution technology R&D in 4 to 5 years. Hazard elimination, like waste control guidance, must be studied on a material-specific basis.

Product #3: Spill Control/Cleanup Technology

Chemical spill cleanup technology is available; however, it must be adapted and organized for use at military installations. New affordable technology for spill control and cleanup is needed for selected Army-unique hazardous materials. For example, POL spill cleanup has been identified as a significant problem.

Product #4: Leachate Control Technology

Past disposal practices have often resulted in hazardous leachate being released from closed, abandoned, or operating sanitary landfills. Installation personnel need guidance to manage leachate. Technology must be developed to control and/or treat leachate.

Product #5: Hazardous Waste Disposal Technology

Since the Army prefers contract disposal and intends to avoid on-post disposal of hazardous wastes, disposal technology is lower priority; however, technological developments could broaden the hazardous waste management options and reduce costs for management and disposal of small-volume wastes. Land

**Table 2
HM/HW Strategy Elements**

Product Systems	Research Activities
Hazardous Materials Management System (HMMS)	Continue development of software for identification and characterization of hazardous materials.
	Develop software to track hazardous materials from entry into the installation supply system to final disposition.
	Develop waste-specific management guidance for collecting, handling, and storing hazardous waste.
	Determine hazardous waste emission factors for use in complying with reporting and inventory requirements.
Hazard Elimination/Minimization Technology	Prepare training materials to educate waste generators in proper handling of hazardous materials.
	Develop techniques for identifying substitute products for hazardous materials.
	Develop technology for recycle/reuse of hazardous wastes.
Spill Control/Cleanup Technology	Develop technology for neutralization or detoxification of hazardous wastes.
	Evaluate and develop spill control/cleanup technologies and procedures for installation use.
Leachate Control Technology	Evaluate and develop technologies to prevent and control leachate.
	Develop leachate treatment technology.
Hazardous Waste Disposal Technology	Develop technology for land disposal of hazardous wastes.
	Develop technology for incineration of hazardous wastes.
Biotechnology	Develop new bacteria which can degrade hazardous wastes or decontaminate spills of hazardous materials.

Table 3
Hazardous Materials/Hazardous Waste R&D Strategy

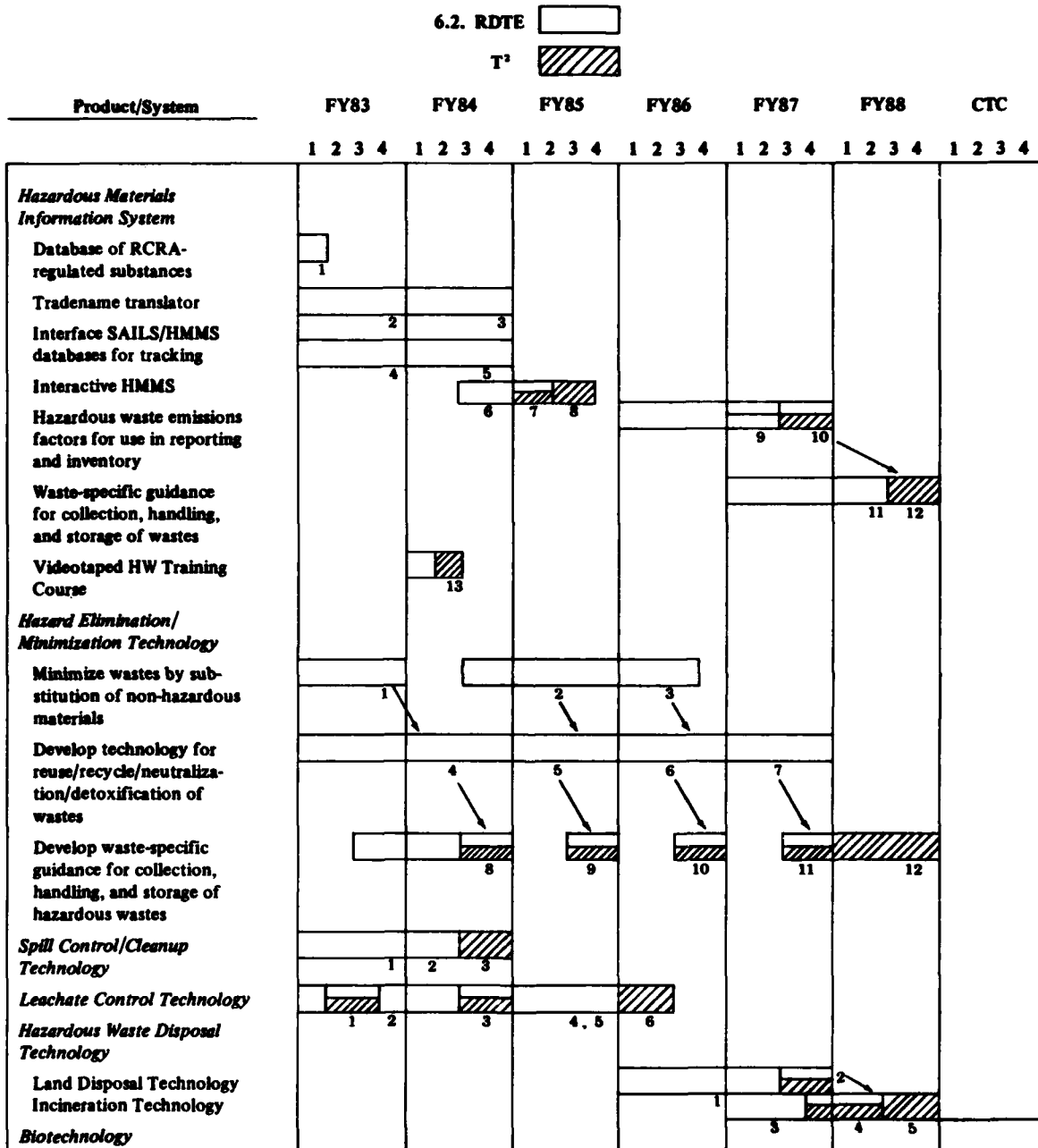


Table 4
Key Event Descriptions

HMMS

1. Complete pilot system on RCRA-regulated substances.
2. Complete software development on tradename translator.
3. Complete tradename translator database.
4. Feasibility study on SAILS/HMMS interface.
5. Interface SAILS/HMMS, if feasible.
6. Initiate field demonstration of HMMS.
7. Provide system documentation, user manuals, and training materials.
8. Complete technology transfer of HMMS with initial training.
9. Determine hazardous waste emission factors for use in complying with reporting and inventory requirements.
10. Provide ETN on hazardous waste emission factors.
11. Complete waste-specific guidance for collecting, handling, and storing hazardous wastes.
12. Contribute to TM on hazardous materials/wastes management.
13. Complete videotape HW training course.

Hazard Elimination/Minimization Technology

1. Substitution technology for solvents.
2. Substitution technology for acids.
3. Substitution technology for paint wastes.
4. Recycle, reuse, neutralization, and detoxification (RRND) technology for solvents.
5. RRND technology for acids.
6. RRND technology for paint wastes.
7. Asbestos neutralization and disposal technology.
8. ETN on solvent management technology.
9. ETN on acid management technology.
10. ETN on paint waste management technology.
11. ETN on asbestos management technology.
12. TM on management of hazardous materials and wastes.

disposal and incineration technology are of interest in this regard.

Product #6: Biotechnology

Biotechnology is a high-risk research area in which bacteria are developed, through genetic engineering, to consume or neutralize selected wastes. Potential benefits could be realized in disposal, spill cleanup, or leachate treatment.

4 STATUS OF ONGOING RESEARCH

Hazardous Materials Information System

The Hazardous Materials Management System (HMMS) was originally programmed to identify chemi-

Spill Control/Cleanup Technology

1. Evaluate and select spill control/cleanup technologies for POL substances.
2. Develop technologies for other selected substances.
3. Develop ETN on spill control/cleanup (include in TM on hazardous materials/wastes management).

Leachate Control Technology

1. ETN on gas control/management at landfills.
2. ETN on liners and covers for landfills.
3. ETN on leachate recycling technology.
4. Develop activated carbon technology for use in lagoon treatment of leachate.
5. Develop robotics for automatic monitoring of landfills.
6. TM on leachate management technology.

Hazardous Waste Disposal Technology

1. Develop technology for land disposal of hazardous wastes.
2. Conduct field evaluation of land disposal technology.
3. Develop incineration technology for disposal of hazardous wastes.
4. Conduct field evaluations of incineration technology.
5. Complete TM on hazardous waste disposal technology.

Biotechnology

Initiate when appropriate technology is available for application at Army military installations.

cal substances which are subject to hazardous waste regulations, either by listing or definition. Several chemical information sources were searched to identify synonyms and trade names of the listed hazardous wastes and the chemical, generic, and trade names of compounds described by one or more definitions of hazardous waste. In February 1982, this database contained 10,565 compounds and is currently being further developed.

The system has been expanded to provide both regulatory and management information. Department of Transportation regulations for hazardous materials have been provided in full. RCRA regulations for generators, substances excluded from regulation under RCRA, and the four legal definitions of hazardous waste are also available. In addition, 31 Technical Data Sheets for Managing Hazardous Waste, developed by

HQ TRADOC, are accessible under HMMS, along with supplementary information on these 31 compounds taken from the Coast Guard's Chemical Hazards Response Information System (CHRIS).

Hazardous Waste Control Guidance

Major accomplishments in the work to develop hazardous waste control guidance include guidelines for hazardous waste survey, POL reuse, and solvent management. Technology is also being developed to minimize solvent wastes through substitution or reuse. An algorithm for PCB transformer retrofit/replacement is also being developed.

Leachate Control

A CERL report dealing with the characteristics, control, and treatment of leachate at Army military installations, has been completed.² Information from this report is being used to update TM 5-634.³ Guidance on hydrologic simulation of solid waste disposal sites has also been issued. Lagoon treatment technology is compiled and guidance is in the publication stage. Ongoing efforts address gas control, landfill liners and covers, and use of activated carbon filters for improving the quality of landfill leachate lagoon effluent.

²W. J. Mikucki, et al., *Characteristics, Control and Treatment of Leachate at Military Installations*, Interim Report N-97/ADA097935 (U.S. Army Construction Engineering Research Laboratory, 1981).

³*Refuse Collection and Disposal Repairs and Utilities*, TM 5-634 (Department of the Army, 2 July 1958).

5 CONCLUSIONS

Installations' technology needs for implementing current DOD HM/HW policies can be grouped into five areas: information management, materials handling, hazard elimination, disposal, and construction design.

Six product/systems are proposed to develop the technology to meet these needs:

1. Development of a Hazardous Materials Management System which would identify and characterize hazardous materials.
2. Development of technology for eliminating or minimizing hazardous wastes through application of substitution, reuse, recycle, and neutralization.
3. Development of technology for adapting current spill control and cleanup technology for use at military installations.
4. Development of technology to control and/or treat leachate.
5. Investigation of hazardous waste disposal options.
6. Investigation of the use of biotechnology to consume or neutralize certain wastes.

APPENDIX: MEMORANDUM FOR RECORD—HAZARDOUS WASTE USER GROUP MEETING

CERL-EN

MEMORANDUM FOR RECORD

SUBJECT: Hazardous Waste User Group Meeting

1. TIME AND PLACE: 24 Jun 82 at Olde Colony Motor Lodge, Alexandria, VA.

2. ATTENDEES: See Incl 1.

3. AGENDA: See Incl 2.

4. SUMMARY OF MEETING:

a. The hazardous waste program presented by CERL was fully supported by the user group. The user group further refined CERL's hazardous waste program by prioritizing the program into the following areas:

- (1) Development of the hazardous materials management system (HMMS).
- (2) Hazardous waste elimination/minimization.
- (3) Spill control technology.
- (4) Specific hazardous waste control guidance.
- (5) Disposal technology.

b. The user group decided that an In-Process Review (IPR) of the hazardous waste program was not appropriate at this time. They did decide, however, that when the HMMS is ready for its AR 18-1 PET, an IPR should be scheduled for that work unit first.

5. NARRATIVE:

a. The morning session went as scheduled with Mr. Riggins restating the purpose of the meeting and the CERL principal investigators describing their on-going R&D in the hazardous waste, hazardous materials management system and the leachate areas.

b. The attendees' comments are as follows:

(1) *Mr. Norris Holloway (DLA):*

(a) DOD Directive 4165.60 is being revised and has a chapter on waste POL.

(b) Oil can be re-refined through a closed loop agreement using the Service-Contract approach. This method precludes a lot of disposal and supply red tape and is favored by DLA.

CERL-EN

SUBJECT: Hazardous Waste User Group Meeting

(c) ID of hazardous waste is important and lab analysis may be required. DPDO's have been instructed not to accept hazardous waste unless it is identified by the user and is properly packaged.

(d) DPDO will dispose of all PCB's and PCB contaminated materials.

(e) Hazardous waste neutralization is an area that needs R&D.

(f) Chapter 10 of DOD 4160.21-M (Defense Disposal Manual) is being rewritten. A draft should be available for Dave Palmer's review by Oct 82.

(g) Conforming storage has been programmed at 37 installations so far (6 MCA and 31 minor construction). The Installation Commander makes the final decisions on who has conforming storage when there is controversy. Storage should be designed to accommodate the needs of the specific commodities.

(2) *Mr. Dave Palmer (DAEN-ZCE):*

(a) Spill prevention is important and should be addressed.

(b) Landfill siting guidelines are needed.

(c) Emphasized cooperation between intergovernmental agencies with the R&D labs picking up the slack when technical assistance and development is needed.

(d) Stressed the overall DOD mission with Environmental R&D taking a supporting role.

(3) *Mr. Harry DeLong (DARCOM):*

(a) Identification of those materials that have one or more hazardous characteristics is the major problem at installation level in complying with RCRA. Development of HMMS should be assigned first priority.

(b) Prevention of spills is important, especially for used oil.

(c) Sanitary landfill siting criteria is important and will be more important in the future.

(d) Emphasizes "womb to tomb" guidance for hazardous wastes, especially solvents.

(e) Prevention of hazardous waste by better management techniques is very important.

(f) Agreed that only feasible method for making valid minimization/substitution guidelines involves targeting a highly consumptive process and doing detailed process analysis.

(4) *LTC Jimmy Young (HQ TRADOC):*

(a) R&D should be oriented more to the users rather than the management types.

(b) Would like to see specific hazardous waste information on packaging, labeling, handling and disposal.

(c) The hazardous waste menu of HMMS is a step in the right direction.

CERL-EN

SUBJECT: Hazardous Waste User Group Meeting

(5) *CPT Mark Dreher* (Fort Sill): Would like to see spill prevention and cleanup technical guidance.

(6) *Carl Divinyi* (Fort Benning): Needs information on storage, handling, transportation, disposal, etc., such as that proposed for inclusion in HMMS.

(7) *Raymond Leone* (Fort Hood): Comments are in Incl 3.

6. RECOMMENDATION FOR STRATEGY DEVELOPMENT:

a. Emphasis of the hazardous waste control technology work unit should be placed on hazard elimination technology, to prevent problems, rather than on waste control and disposal. Appropriate changes will be made to the strategy to reflect this concern.

b. Disposal technology is low priority but could be kept in the program as a potential research topic.

c. The next step in strategy development is to finalize the research areas and priorities and assign funding requirements to research activities.

7. CONCLUSIONS: The user group is an effective and worthwhile body for accomplishing program verification and to provide user guidance.

BERNARD DONAHUE

Principal Investigator

MANETTE MESSENGER

Principal Investigator

ROBERT RIGGINS

Program Manager

WALTER MIKUCKI

Team Leader

Incl 1

Name	Organization	Phone
Mark Dreher	Fort Sill-EN	AV 639-2715
Carl Divinyi	Fort Benning	AV 835-4766
David G. Palmer	HQDA, DAEN-ZCE	AV 224-3434
Harry P. DeLong	HQ DARCOM	AV 274-9016
Robert T. Flowe	HQDA, DAEN-RDM	AV 285-0259
Marcia Read	HQDA, DAEN-MPO-U	AV 285-0588
Noris E. Hollaway	HQ DLA, DLA-SME	AV 284-7503/4
Alex Iskandar	US CRREL	603-643-3200
Randy Hanna	Fort Lewis, WA	AV 357-4076/5337
Raymond W. Leone	Hood-EPO	AV 737-6405 FTS 747-6405
Frank Bizzoco	HQDA, DAEN-MPE-D	285-0414
LTC Jimmy L. Young	HQ TRADOC (ATEN-FN)	AV 680-2363/3300
Robert Riggins	CERL-EN	FTS 958-7234
Walter Mikucki	CERL-EN	FTS 958-7227
Manette Messenger	CERL-EN	FTS 958-7427
Bernard Donahue	CERL-EN	FTS 958-7418

Incl 2

AGENDA
HM/HW User Group
24 June 1982

0800 - 0830	Strategy Objectives	Mr. Riggins
0830 - 1015	Ongoing HM/HW Work	Mr. Donahue
		Mr. Mikucki
		Ms. Messenger
1015 - 1030	Break	
1030 - 1130	MACOM and User Goals	LTC Young
		Mr. Alexander
		User Representatives
1130 - 1200	Interagency Cooperation	Mr. Palmer
1200 - 1300	Lunch	
1300 - 1330	Strategy Review	Mr. Riggins
1330 - 1600	Discussion	
1600 - 1630	Summary	Mr. Riggins

Incl 3

R&D MEETING - HAZARDOUS WASTES

Suggestions:

I. HW Manual

A. Types and properties of HW/HM common to U.S. Army installations

1. Solvents
2. Waste electrolyte
3. STB
4. DS-2
5. PCB transformers
6. Pesticides

B. Proper disposal procedures

C. Proper reporting procedures

D. Synopses of HW Regulations

II. Study to Consolidate Solvent Usage

A. Substitution of non-hazardous solvents for hazardous solvents.

B. Substitution of less expensive for more expensive solvents that perform the same function.

C. Installation of bulk solvent dispensing points to reduce volumes of solvents being purchased in smaller quantities (i.e., 1-, 5-gallon cans).

III. Study to Determine Feasibility of Recycling Solvents - solvent recovery unit.

IV. Development of Computer Program to Track HW/HM from Entry to Disposal.

V. Neutralization of PCB Fluids - to reduce inspection efforts and to avoid complex disposal procedures (i.e., handling, storage, testing, manifesting, etc.).

VI. Standard HW Management Plan for Installation Use.

VII. Videotaped HW Training Course that will meet the requirements of 40 CFR 265.16.

VIII. Central Data File Containing Solvent/HM Information (i.e., NSN's, Manufacturers, Hazards, Chemical Formulae, Handling Procedures, Disposal Procedures, etc.).

SOLVENT CONSUMPTION AT FORT HOOD

Approximately 38,250 gallons of various solvents are purchased each year at Fort Hood. Solvent costs per gallon vary from \$1.01 to \$15.46. Currently, used solvents are disposed of through DPDO, mixed with used oil and sold to a contractor, dumped into a sand/oil interceptor, or discarded into the sewer. If only 40% of Fort Hood's annual solvent consumption (or 15,300 gallons) were selectively distilled (at a cost of 20 cents per gallon for collection and distillation unit operation) a savings of \$19,890 per year would be realized (average cost of solvent = \$1.50/gallon).

<i>NSN</i>	<i>TYPE</i>	<i>MIL SPEC</i>	<i>COST PER GAL</i>	<i>USE</i>
6850-00-144-9816		MIL-C-43616	\$3.76	Aircraft Surface
6850-00-105-3804			\$1.58	Cleaning Compound
6850-00-144-9817		MIL-C-43616	\$2.83	Aircraft Surface
6850-00-224-6665		MIL-C-11090	\$4.35	
6850-00-264-9037	I	PD-680	\$1.01	Dry Cleaning
6850-00-264-9038	I	PD-680	\$2.60	Dry Cleaning
6850-00-264-9039	I	PD-680	\$1.19	Dry Cleaning
6850-00-274-5421	II	PD-680	\$2.86	Dry Cleaning
6850-00-281-1985	I	PD-680	\$3.40	STODDARD, Dry Cleaning
6850-00-285-8011	II	PD-680	\$2.49	Dry Cleaning
6850-00-285-8012	I	PD-680	\$2.01	Dry Cleaning
6850-00-292-9700		MIL-20207	\$3.92	Not Suitable for Zinc or Aluminum
6850-00-597-9765			\$4.20	Cleaning Compound Solvent
6850-00-637-6135	II	PD-680	\$1.19	Dry Cleaning
6850-00-935-0995			\$1.76	Cleaning Compound, Acft. Sol.
6850-00-984-5853		MIL-C-81302	\$15.46	Trichlorotrifluoroethane

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I. Riggins, Robert E. II. Mikucki, Walter J. III. Donahue, Bernard A.
IV. Messenger, Manette V. Series: Technical report (Construction Engineering
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